

(12) PATENT ABSTRACT

(11) Document No.

AU-A-10206/95

(19) AUSTRALIAN PATENT OFFICE

(54) Title

MULTI-CHAMBERED INFLATABLE APPARATUS AND CONTROL UNIT THEREFOR

International Patent Classification(s)

(51)⁶ A61G 007/00

A47C 027/10

A61G 005/10

(21) Application No. : 10206/95

(22) Application Date : 16.01.95

(30) Priority Data

(31) Number (32) Date (33) Country
PM3512 25.01.94 AU AUSTRALIA

(43) Publication Date : 03.08.95

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In one general arrangement the invention comprises the combination of an inflatable apparatus 131 connected via connector 130 with control device 132, which in turn is connected to the compressor 134, with monitoring of the supplied pressure done by pressure sensing apparatus or gauge 136.

The inflatable apparatus 131 comprises a series of sections separated from each other but joined together by connecting strips or links (see Figure 1) which may be of a fixed or variable width of material to allow the spacing of the sections to be altered to suit the particular application. The sections have various separately inflatable chambers 38,20,22,24,44,45,46 to support the body 62 on the bed or operating table 60. The strips when variable may comprise velcro strips or material linked by zippers, hook and eye, buttons and button holes, press studs, or similar joining mechanisms.

Connector 130 allows the control device 132 to be disconnected without pressure loss while control device 132 allows separate inflation or deflation of each chamber of the inflatable apparatus 131 .

**MULTI-CHAMBERED INFLATABLE APPARATUS AND CONTROL UNIT
THEREFOR**

FIELD OF THE INVENTION

This invention relates to a multi-chambered inflatable body supporting apparatus and to a device for controlling inflation of same.

BACKGROUND OF THE INVENTION

A variety of inflatable mattresses, whether for recreational or medical uses, are well known. These provide both comfort and postural support for an incumbent. There is in particular a need in bed-ridden patients in geriatric or hospitalised care, to provide support to alleviate or minimise pressure or bed-sores, or to provide support during prolonged surgery on an operating table.

There is also a multitude of other applications where support of a person's various body parts is required or beneficial, especially when a given position is maintained for prolonged periods. Examples which may be cited are: during vehicular travel such as by motor vehicles or aircraft, or recreational use, such as for camping beds, or chairs, or as floatation aids.

There is also a separate need for a control device for inflating such an apparatus or in general to provide the control of inflation of such items as air mattresses, motor vehicle tyres, or buoyancy devices.

SUMMARY OF THE INVENTION

The present invention seeks to provide a multi-chambered inflatable apparatus or a control device for inflating such an apparatus, which overcomes or ameliorates the disadvantages of similar

prior art apparatus, or provides an alternative thereto.

According to a first aspect of the invention there is provided a multi-chambered inflatable apparatus including a plurality of sections to cover a predetermined body area, said sections being separate one from the other and each section including a plurality of separately inflatable chambers provided with individual respective apertures through which an inflating fluid may enter or leave said chambers to allow each chamber to be pressurised to a respective pressure.

According to a further aspect of the invention the aforesaid multi-chambered inflatable apparatus has adjacent of said sections joined by joining means. Preferably, the joining means may allow the spacing of adjacent sections to be varied to accommodate the application or the dimensions of the body to be supported but may be of fixed dimensions.

Preferably, the inflating fluid is a gas since a gas will occupy the available volume, do this more evenly than a liquid, and, being compressible, will allow the apparatus to conform more to the contour of the weight or body imposed upon it. Other features of the inflatable apparatus will be apparent from the description which follows.

For instance, the inflatable apparatus may extend to support the full extent of a person's body when lying prone, seated or inclined or merely a part or parts thereof. For example, for a paraplegic or quadraplegic patient in a wheel chair, it may be only necessary to support the patient from the waist to the feet. The sections supporting separate body parts may

be in different planes.

If the whole body is to be supported then separate sections may be used, for example for supporting the head, and neck in one section; the torso in another; the buttocks in a further section and the lower limbs in another section, although other arrangements to support a body may be used depending on the application.

According to a second aspect of the invention there is provided a fluid control device including one set of outlet control elements, each being connected between a source of fluid under pressure and an outlet for said fluid under pressure, and a second set of inlet control elements, each connected between an inlet from a volume pressurised by said fluid, and with which a said outlet is communicatable, and a sink for said fluid.

When the control device is used in combination with the multi-chambered inflatable apparatus the number of outlets and inlets equals the number of independent chambers allowing separate inflation and deflation of chambers of the apparatus. In its simplest form, the control device comprises a single outlet control element and a single inlet control element enabling a single volume to be inflated and deflated to a desired pressure, for example with the inclusion of a meter or gauge for determining the pressure contained within the volume.

According to a further aspect of the invention there is provided a piece of inflatable furniture including:

a multi-chambered inflatable apparatus including a plurality of sections to cover a predetermined body

area, said sections being separate one from the other and each section including a plurality of separately inflatable chambers provided with individual respective apertures through which an inflating fluid may enter or leave said chambers to allow each chamber to be pressurised to a respective pressure;

a fluid control device including one set of outlet control elements each being connected between a source of fluid under pressure and an outlet for said fluid under pressure, and a second set of inlet control elements each connected between an inlet from each of said chambers to be pressurised by said fluid and with which said outlet is communicatable, and a sink for said fluid, the number of outlets and inlets equalling the number of independent chambers thereby allowing separate inflation or deflation of each such chamber of said apparatus;

means connecting said outlets and inlets of said fluid control device to said respective chambers of said inflatable apparatus; and

means for connecting said fluid control device to a source of fluid pressure.

The source of fluid pressure may comprise a compressor, bottled gas or similar within the knowledge of a person skilled in the art.

Preferably, the control device may be disconnected from the inflatable apparatus without resulting in deflation or loss of substantial pressure in the chambers thereof. This enables the control device to be usable with a number of inflatable apparatus. For this purpose a connector with valving would be included as a part of said connecting means inserted

between the inflatable apparatus and the control device.

In addition, the inflatable apparatus may be combined with pressure sensors to sense the pressure in one or more chambers or in the connecting means supplying fluid to inflate the chambers to provide regulation of the pressure supplied, for example to prevent over-inflation or to enable an inflation regimen or sequence to be repeated.

Throughout the specification wherever the expression "body" is used it is to be understood to include animals of all types as well as humans per se, as the invention is contemplated as equally applicable to veterinary uses.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be described with respect to the following figures in which:

Figure 1 shows a first embodiment of the inflatable apparatus according to the invention;

Figure 2 shows a first embodiment of the control unit according to the invention;

Figure 3 shows a cross section of Figure 2 illustrating the internal fluid pathways;

Figure 4 shows the connector for the control device of Figures 2, and 3;

Figure 5 illustrates a second embodiment of the control unit according to the invention incorporating

pressure sensing means;

Figures 6-9 show various embodiments of furniture incorporating the features of the invention;

Figure 10 shows an embodiment of the inflatable apparatus with skirts according to the invention; and

Figure 11 shows another embodiment of the inflatable apparatus according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figure 1 the inflatable apparatus according to one embodiment of the invention comprises a series of sections 10,12,14 separated from each other but joined together by connecting strips or links 16,18.

In general, links or strips 16, 18 may be of a fixed or variable width of material. In this embodiment, the widths of the strips 16, 18 are variable to allow the spacing of the sections 10,12,14 to be altered to suit the particular application. The strips 16,18 may then comprise velcro strips or material linked by zippers, hook and eye, buttons and button holes, press studs, or similar joining mechanisms, which allow the spacing of the sections to be varied.

Having the various sections 10,12,14 separable allows the inflatable apparatus to be more conveniently positioned depending on the height of the person, or the use of the apparatus, in particular whether it may be used in a prone position as in a bed or bent as in a chair or seating application. Where strips 16,18 are of a fixed width, this width is such as to allow the various sections to be folded, for example when the apparatus is used as a support for a chaired

person or for stowage in its uninflated condition.

Each section is divided into a number of chambers. Section 10, which in this embodiment is designed to support the torso, includes one chamber 20 to support the shoulder area, a second chamber 22 to support the mid-back and a third chamber 24 to support the lower back. As shown, the chambers 20,22 are interconnected by the channel 28 enabling a single inflation point 30 to be used for both chambers 20,22. The lower back chamber 24 is inflatable separately via line 25.

In addition the sides 32,34 can also be inflated together but separately of the other chambers 20,24 through the air supply line 36, which is common to both, using a T-piece connection 58. A separate head section 38 can also be inflated through the connection 40 to allow support of the head and neck.

The central section 12 supports the gluteal region of a person's body and has two separately inflatable chambers 42,44 covering respectively the perimeter and central region of the section 12. Chamber 44 has a further internal chamber 43 communicating therewith through aperture(s) 41 (only one shown). Chambers 42,44 of section 12 are supplied through a common supply line 52 having branches 54,56 to the separate chambers 42,44. A variation of section 12 is described below with respect to Figures 10 and 11.

The lower section 14 has two separately inflatable chambers 45,46, to support the legs and knees on the one hand, and the heels respectively on the other. Chamber 45 is inflatable (deflatable) via line 82, while chamber 46 has separate inflating line 84 and deflating line 86 (or vice versa). In addition, section 14 has two chambers 48,50 along the edges of

the section 14 which may be jointly inflated through the common supply line 80 forming a T-junction branch to each chamber.

In the configuration as shown the inflatable apparatus may be lain flat upon an operating table and secured in place by suitable velcro strapping or other bindings (not shown). Such an implementation is shown in Figures 9a and 9b, which show the inflatable apparatus 131 on operating table 62 in side elevation and from the head end respectively.

Referring to Figure 9a, the various chambers 38, 20, 22, 24, 44, 45, 46 are shown in side elevation supported on the bed or operating table 60. The various chambers which are of different volume, and size, are inflated to different pressures to provide the desired contour to support the prostrate figure 62. This figure 62 may be upon an operating table as stated above, or simply upon a bed.

As shown more clearly in Figure 9b the inflatable apparatus may also support the body laterally by the chambers 32,34 or 48,50 being inflated to provide side support. This side support may also be provided, in the absence of specific side chambers 32,34,48 or 50, although less effectively, by relying upon the region of the central areas of the inflatable chambers of the apparatus being compressed as a result of the weight imposed thereon. That is, due to the compressibility of the gas in the chambers the body would form a central depression with upraised sides.

It is also contemplated that some or all of the chambers have skirts 64 (as shown in Figure 10), inner sections of welded or sewn material inside the chambers, to constrain or help form the shape of the

chamber upon inflation to thereby provide the desired contouring or support. Holes 65 in the walls of the skirts 64 allow fluid to inflate the interior of the chamber as indicated by arrows 63.

A variation of the inflatable apparatus of Figure 1 is shown in Figure 11. Here the section 12 only is shown with chambers 42, 43 and 44 as stated above inflatable through a common supply line 52 having branches 54,56 to the separate chambers 42, 44 (and 43). In addition a further chamber 47 extending across the width of the apparatus and inflated by supply line 49 is included to support the underneath of the upper thighs. The inclusion of this chamber has particular application to vehicular uses of the apparatus.

The inflatable apparatus may be made of flexible plastics material such as PVC or a rubberised cloth, for example as used in air mattresses. The quality of the material will depend upon the use to which the inflatable apparatus is to be put. For example, if the inflatable apparatus is intended to have a single use as in an operating theatre, being disposed of after use, then it may in such a case, be made of a less durable material or the material may be thinner.

In a further embodiment, the inflatable apparatus may be provided with means to regulate the temperature of the air admitted to the various chambers. This may be done as a single action, for example heating the apparatus to a comfortable body temperature in order to make its initial contact with the skin of the supported body more comfortable. Alternatively, the temperature regulation may be performed on a ongoing basis to aid the temperature regulation of the superposed body.

The temperature regulation may be to maintain the standard body temperature or may be used to lower the body temperature during operations.

A further modification to this temperature regulation embodiment of the invention includes separate air outlets 70,72 located for example underneath the seat (outlet 72) or lower back area (not shown) of the apparatus, or towards the feet area (outlet 70). The outlets 70,72 for example could be tubes closed at one end and having a number of outlets 76 arranged about the circumference and along the length of the tube.

The various inlet tubing 40,30,25,36,52,80,82,or 84 is connected to a common connection point 90 as shown in Figure 4. Each such inlet tubing may also be an outlet for the associated chamber with the direction of fluid flow being defined by a bi-directional valve provided in each tube, or under the action of the control unit to be described below. Alternatively, there may be a separate outlet 86 for a chamber as shown for chamber 46. A separate inlet and outlet may be necessary if the fluid is to be circulated through the chamber as when the chamber's temperature is regulated with the fluid being re-circulated to the chamber after passing through a heating/cooling apparatus.

Referring now to Figures 2 and 3, the control unit 100 comprises a housing 102 in which is located a number of inlet and outlet control valves or elements 104,106 respectively connecting the source of pressurised fluid via line 108 to the various outlet tubes 110 and the sink at 112 to the various inlet tubes 110. The outlet and inlet tubes 110 may be separate or one and the same as described above. Fluid line 108 can be disconnected from the fluid pressure source in the

manner described below with respect to Figure 4, for prongs 122 or lines 90.

In Figures 2 and 3 the inlet and outlet controls are on the same face of the control unit 100. The arrangements of the buttons controlling the inlet and outlet of fluid to the various chambers is a matter of ergonomic design and would also depend on the intended operator. For example, if the operator is disabled or is a person having impaired manual dexterity then the arrangement of the valves and their sensitivity may be varied to accommodate this fact.

The outlet valves 106 connect the associated line 110 to the exit orifice 112 in this model. Alternatively, the outlet valve 106 may connect the line 110 back to the source of fluid pressure. This would be particularly advantageous if temperature regulation of the fluid is employed to minimise energy wastage.

As shown in the cross sectional view of Figure 3 the inlet and outlet valves 104, 106 comprise spring loaded push button valves 105, 107, and can be, for example, Schroeder valves of the type employed in pneumatic tyres. The ends 109, 111 of the valves can be closed by screw threaded members enabling access to the components of the valves for repair or adjustment (for example, to alter the tensioning of the valve springs).

The various lines 110 of the control device 100 would be encased in a flexible sleeve 114 with each line, as shown in Figure 4, terminating in a connector plug 120, forming the male component of the connector, for connecting to the female socket 124, in which the tubes 90 attached to the inflatable apparatus terminate.

The connector components 120,124 may be provided with key ways to ensure a one to one mating of the lines 110 to the lines 90 to ensure proper control of the inflation and/or deflation of the associated chamber by the control device. The connector socket 124 is provided with a spring loaded valve arrangement whereby disconnection of the male component 120 therefrom would not allow fluid escape from the lines 90 and equally upon insertion of the prongs 122 of connector 120 thereinto would allow fluid communication therebetween under control of the control device.

The ends of prongs 122 of connector 120 (or the equivalent for lines 90 of socket 124) may have a press-on or snap-on fit to their mating component, such as a Luer lock, to provide an adequate and disengagable connection.

A suitable source of gas under pressure can be supplied from a compressor or bottled gas, for example compressed air. In an operating theatre where explosive gases are present a neutral gas such as nitrogen may be used. Small portable electrically operated compressors are readily available. Such a compressor might supply air at 6psi while operating at 12 volts dc. Such a compressor can thus be operated from the cigarette lighter of a motor vehicle dashboard or from a suitable power supply pack connected to the mains as is common with much electrical equipment using DC input power.

In addition the pressure of the gas applied to the various chambers may be monitored to ensure that the chambers are not over-inflated and also to provide the basis for repeating a given inflation regimen. That

is, if the comfort of a body was best with the chambers at specified pressures then it would be a simple matter to repeat the inflation of the chambers to these pressures if they had been measured and recorded.

These latter steps may be readily carried out by a microcomputer suitably programmed and provided with input from means to measure the pressure in the chambers (or supplied to the chambers) and with means to record their respective values in a non volatile memory storage of any type well known for this purpose in the art. In other embodiments the pressure may be displayed on a read out so as to ensure that the various chambers are not over-inflated as a result of malfunction of the compressor or a fault developing in the associated tubing. This may comprise a light emitting diode (LED) display and may be integrated with the compressor or gas bottle supply, or the control device.

Alternatively, pressure gauges may be employed for monitoring the pressures of the various chambers.

The inflatable apparatus may be employed for recreational purposes and for the comfort of passengers in such vehicles as motor lorries, passenger cars, airplanes or trains. The inflatable apparatus may come as a separate item which can be attached to the vehicle seat or may be installed as a permanent fixture which is normally deflated but which can be inflated by connection of the control device into the connector socket 124 and activation of the appropriate valves.

In aircraft, it would be necessary to ensure that the inflatable apparatus was not a safety problem under

the reduced atmospheric pressure employed in pressurised cabins or in emergencies in such craft if cabin decompression occurs. These problems may be met by limiting the pressures within the chambers and/or having the apparatus of a sufficiently strong material to withstand the pressure difference and/or having the (springs of) valves of connector 124 calibrated to "leak" or open when a given pressure difference exists between the chamber (line) and the ambient environment.

Figure 5 shows the control device 140, in its simplest form, comprising a single outlet control element 142 and a single inlet control element 144 enabling a single volume, for example a car tyre, to which connector 146 is attached, to be inflated and deflated to a desired pressure. The meter or gauge 149 is included for determining the pressure contained within the volume.

One general arrangement comprising the combination of the above described inflatable apparatus and the aforementioned control device is shown in Figure 9a. Here the inflatable apparatus is connected via connector 130 with control device 132, connected to the compressor 134, with monitoring of the supplied pressure done by pressure sensing apparatus or gauge 136.

Other arrangements are shown in Figures 6, 7 and 8. In Figure 6 a seating module for a vehicle is shown having a compressor 150 at the side and a control device 152 connectable to a socket 154. The seat has a number of chambers 156 arranged along the centre of the back 158 and base 160 of the seat and a number of chambers 162, 164 along the sides. The back 158 and base 160 of the seat are joined or separated by strip

166, which is uninflated. With the chambers 156, 162, 164 being separately inflatable using control device 152 the occupant of the seat can adjust the seat contour to their preferred shaping and, if desired, once set the control device 152 and tube 153 can be disconnected at 154. Alternatively socket 154 may be provided at the control device 152 or in between control device 152 and the seating module.

In Figure 7 the inflatable apparatus 185 is shown laid out on a mattress. In this configuration the inflatable apparatus has an upper layer 185 having a main head or pillow chamber 180 attached to the foot chamber 182 by a trunk section. The trunk section is formed by a series of separate chambers 184, 186 and 188 along its central and side portions respectively with each chamber made up of four interconnected volumes. Using control device 181 the occupant of the mattress can adjust the contour of the apparatus to their preferred shaping and, if desired, once set the control device 181 can be disconnected at 183. The mattress may have a second layer 187 of inflatable apparatus similar in form to that of upper layer 185 and spaced therefrom by the intervening layer 190. Layer 187 may be inflated through tubing 189 using control device 181 as described for the upper layer 185.

In Figure 8 the inflatable apparatus is built as part of a chair with the control unit 200 built into one arm of the chair and the compressor 206 located underneath the seat of the chair. A number of chambers 210, 212, 214 are located across the back of the chair as are a number of chambers 220, 222, 224 across the seat.

Although the invention has been described above with

respect to a variety of preferred embodiments thereof, it is contemplated that variations therein may be made within the knowledge of a person skilled in the art.

I CLAIM:

1. A multi-chambered inflatable apparatus including a plurality of sections to cover a predetermined body area, said sections being separate one from the other and each section including a plurality of separately inflatable chambers provided with individual respective apertures through which an inflating fluid may enter or leave said chambers to allow each chamber to be pressurised to a respective pressure.
2. A multi-chambered inflatable apparatus as claimed in claim 1 wherein adjacent of said sections while separate are joined by joining means.
3. A multi-chambered inflatable apparatus as claimed in claim 2 wherein said joining means allow the spacing of adjacent said sections to be varied.
4. A multi-chambered inflatable apparatus as claimed in claim 3 wherein said inflating fluid is a gas.
5. A multi-chambered inflatable apparatus as claimed in claim 4 wherein the inflatable apparatus extends in length to support the full extent of a person's body when lying prone, or seated with separate said sections covering respectively the head, and neck; the torso; the buttocks and the lower limbs.
6. A piece of inflatable furniture including:
a multi-chambered inflatable apparatus including a plurality of sections to cover a predetermined body area, said sections being separate one from the other and each section including a plurality of separately inflatable chambers provided with individual respective apertures through which an inflating fluid

may enter or leave said chambers to allow each chamber to be pressurised to a respective pressure;

a fluid control device including one set of outlet control elements, each being connected between a source of fluid under pressure and an outlet for said fluid under pressure and a second set of inlet control elements, each connected between an inlet from each of said chambers to be pressurised by said fluid and with which said chamber a said outlet is communicatable, and a sink for said fluid, the number of outlets and inlets equalling the number of separately inflatable chambers thereby allowing separate inflation or deflation of each such chamber of said apparatus;

means connecting said outlets and inlets to said respective chambers of said inflatable apparatus; and

means for connecting said fluid control device to a source of fluid pressure.

7. A piece of inflatable furniture as claimed in claim 6 wherein said source of fluid pressure includes a compressor and further including pressure sensors to sense the pressure in one or more of said chambers or in the lines supplying fluid to inflate said chambers to provide regulation of the pressure supplied to said chamber or chambers.

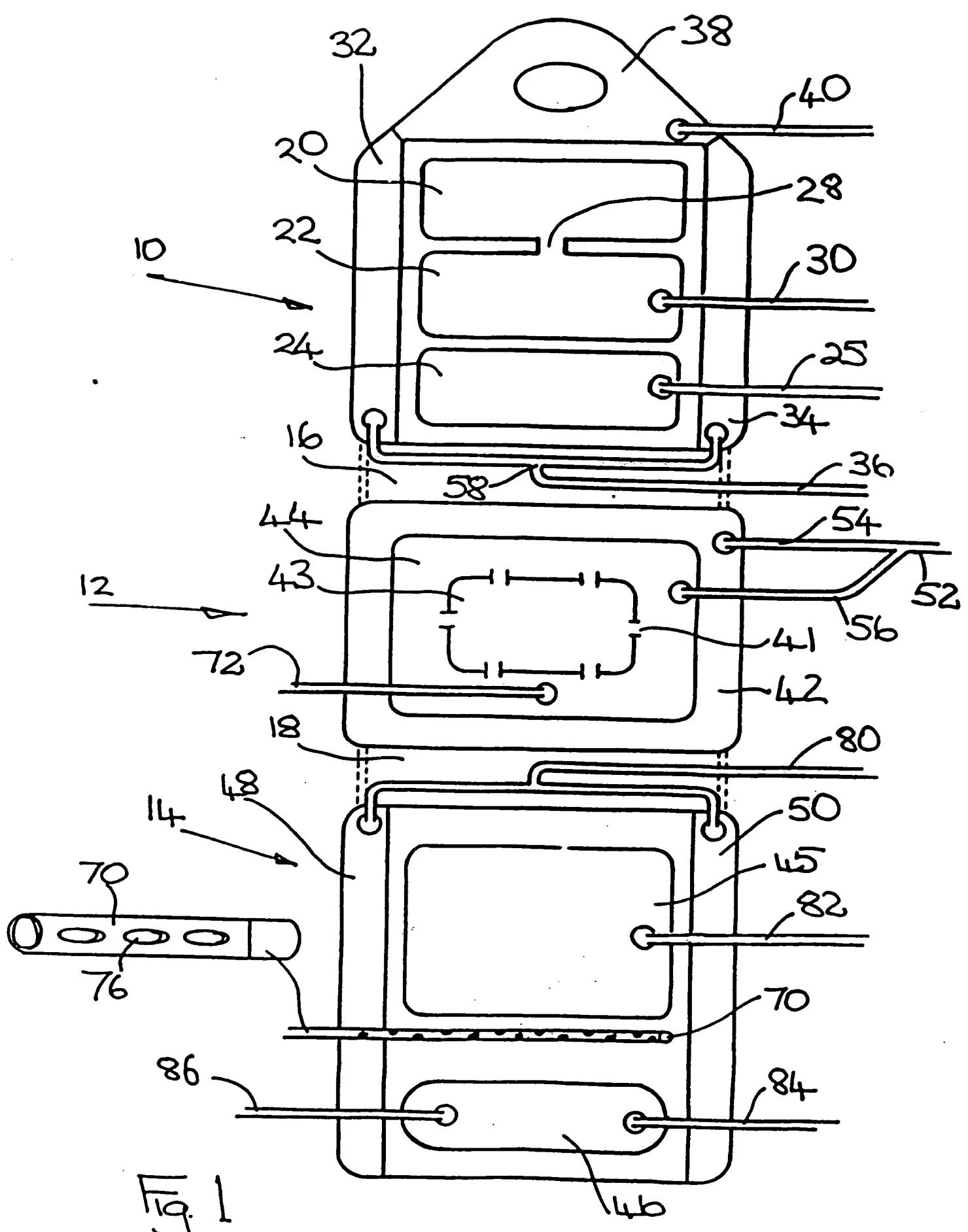
8. A piece of inflatable furniture as claimed in claim 7 wherein said connecting means allow the control device to be disconnected from the inflatable apparatus without resulting in deflation or substantial loss of pressure in the chambers thereof.

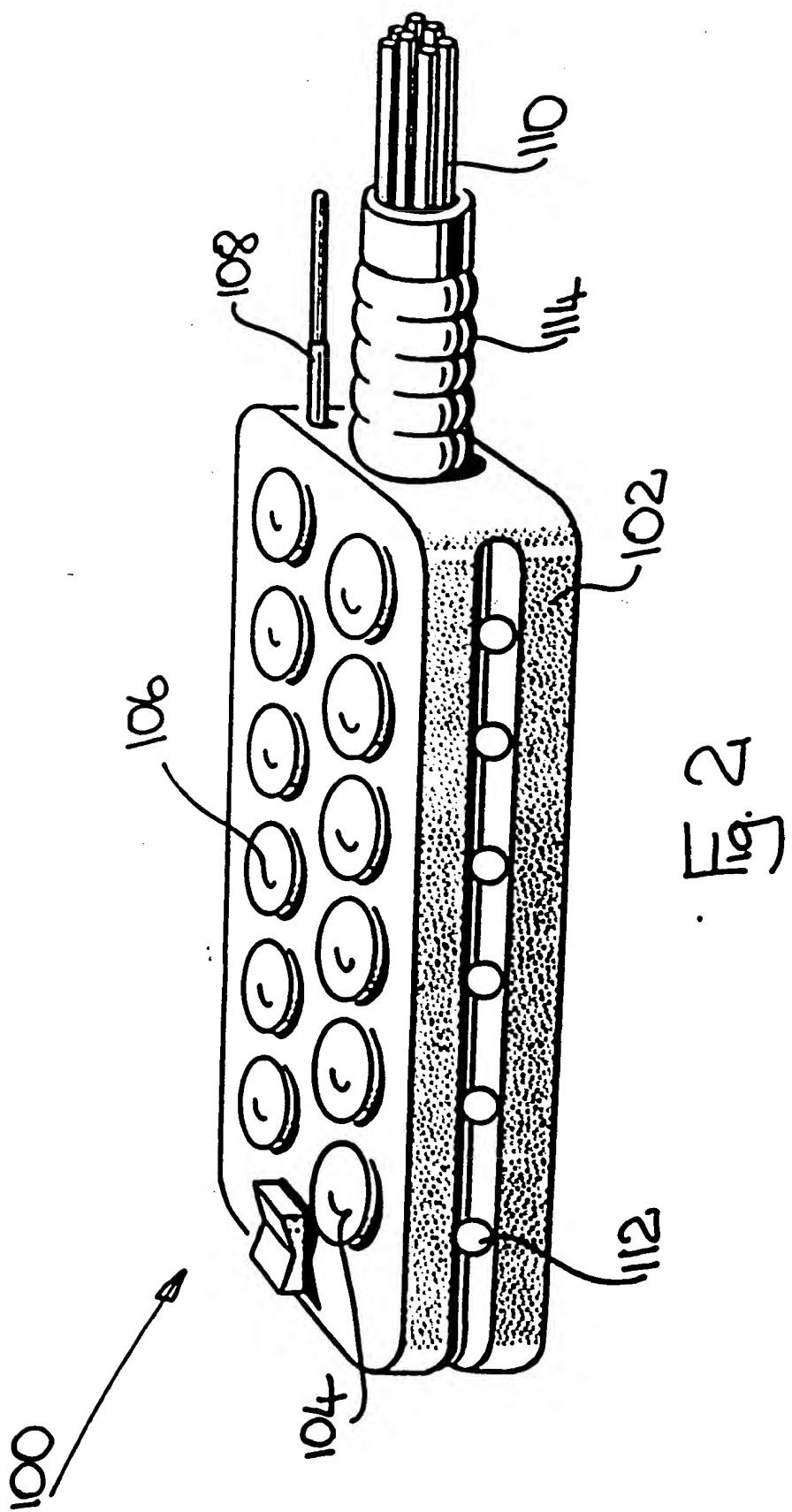
ABSTRACT OF THE DISCLOSURE

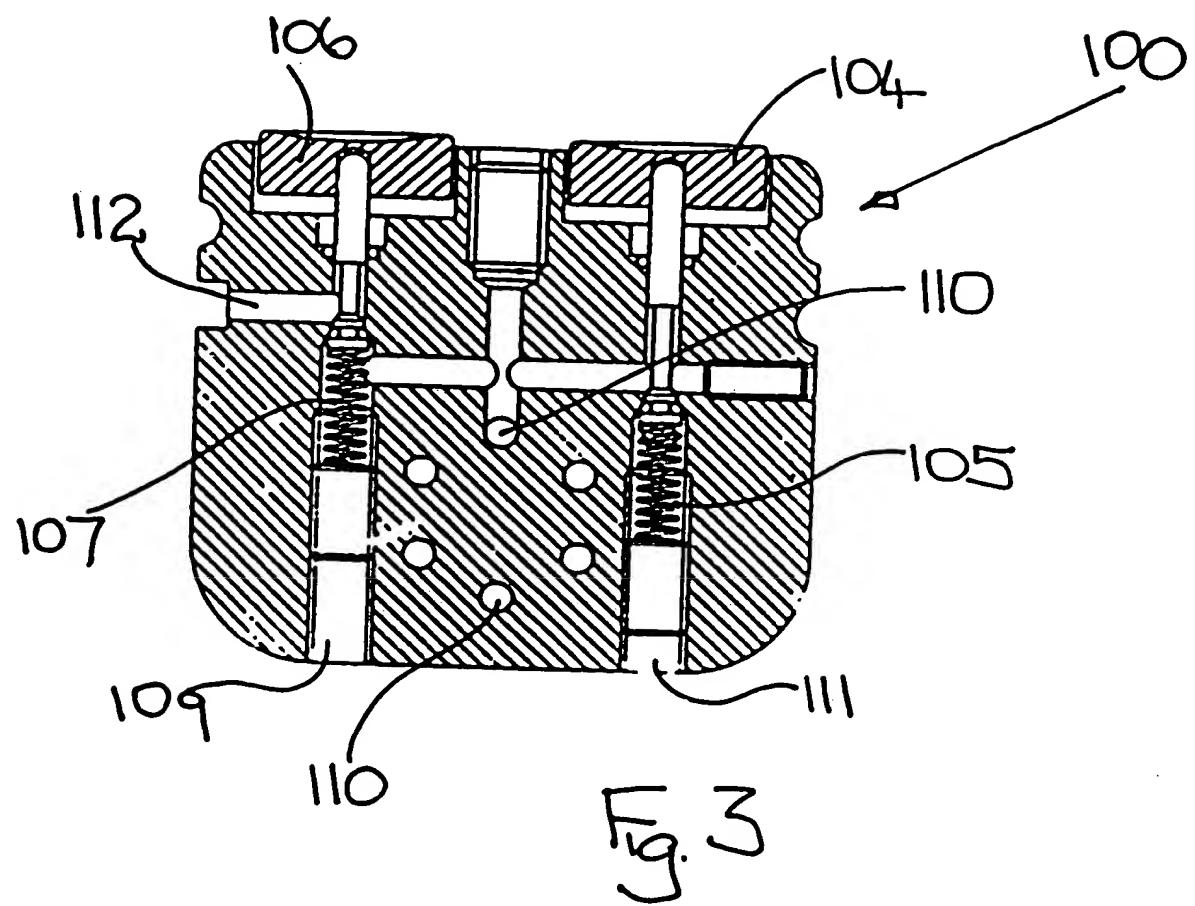
In one general arrangement the invention comprises the combination of an inflatable apparatus 131 connected via connector 130 with control device 132, which in turn is connected to the compressor 134, with monitoring of the supplied pressure done by pressure sensing apparatus or gauge 136.

The inflatable apparatus 131 comprises a series of sections separated from each other but joined together by connecting strips or links (see Figure 1) which may be of a fixed or variable width of material to allow the spacing of the sections to be altered to suit the particular application. The sections have various separately inflatable chambers 38,20,22,24,44,45,46 to support the body 62 on the bed or operating table 60. The strips when variable may comprise velcro strips or material linked by zippers, hook and eye, buttons and button holes, press studs, or similar joining mechanisms.

Connector 130 allows the control device 132 to be disconnected without pressure loss while control device 132 allows separate inflation or deflation of each chamber of the inflatable apparatus 131 .







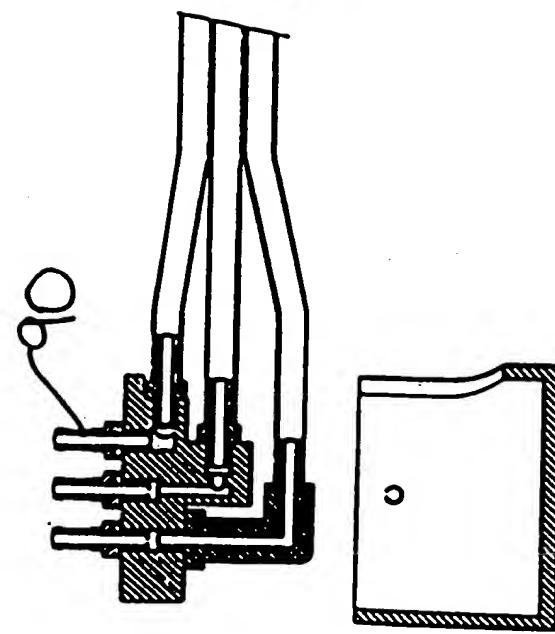
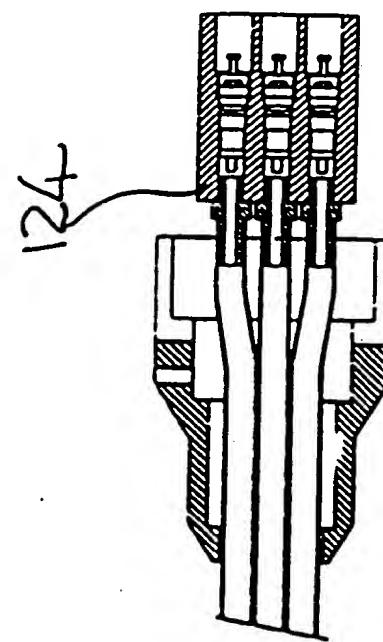
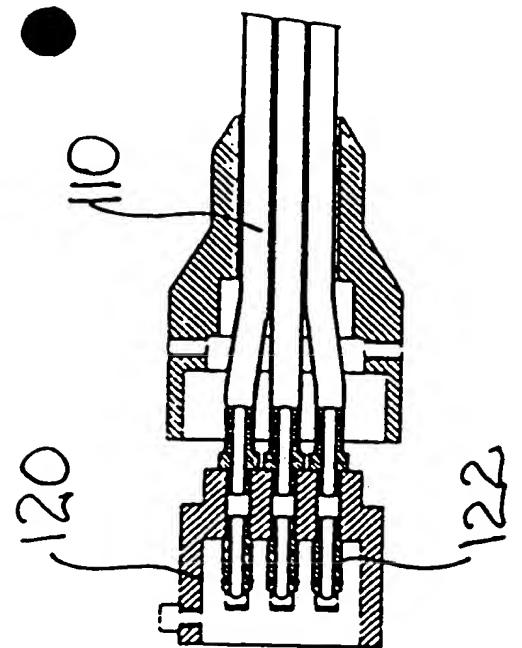
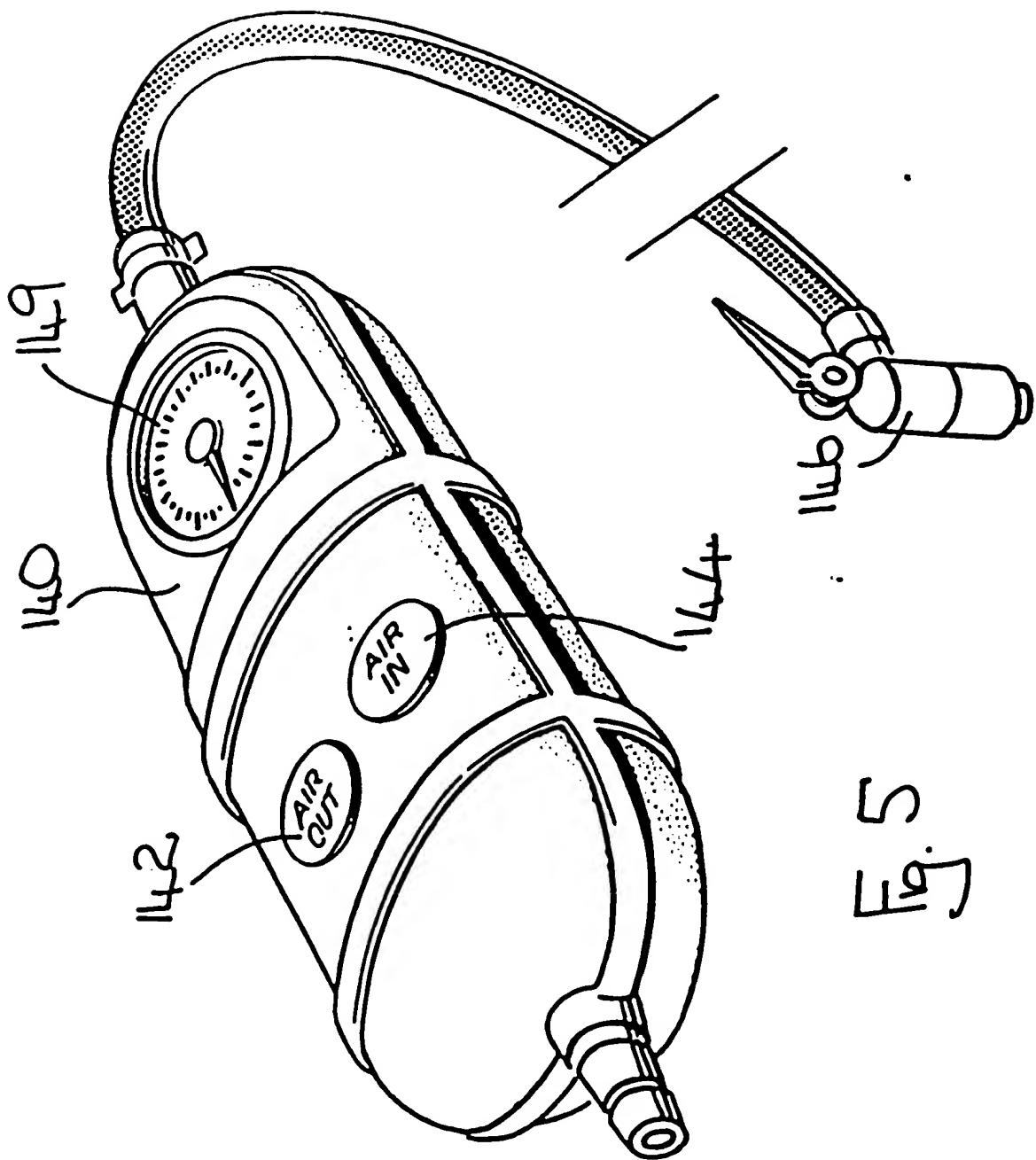


Fig. 4



10206/95

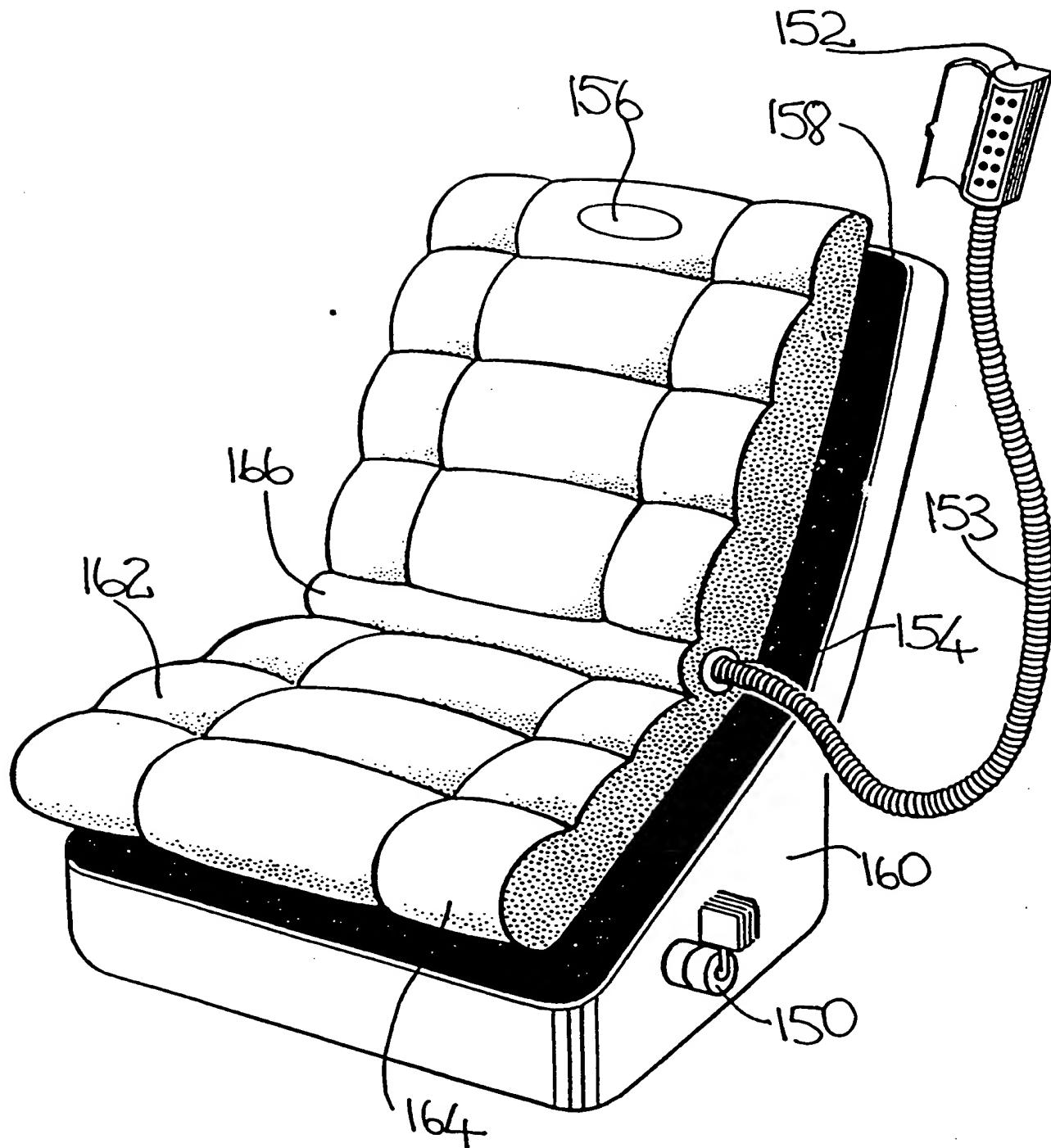
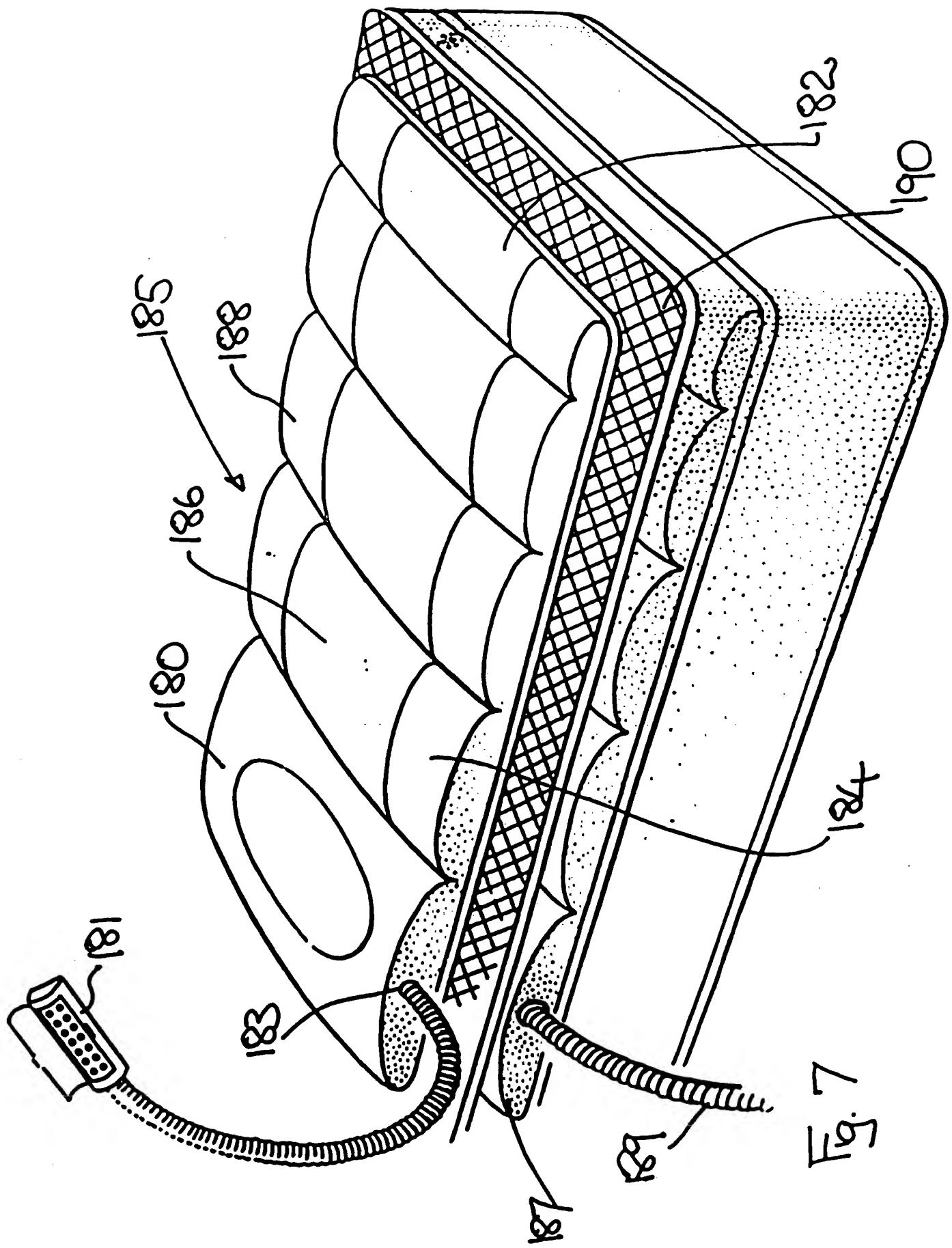


Fig. 6



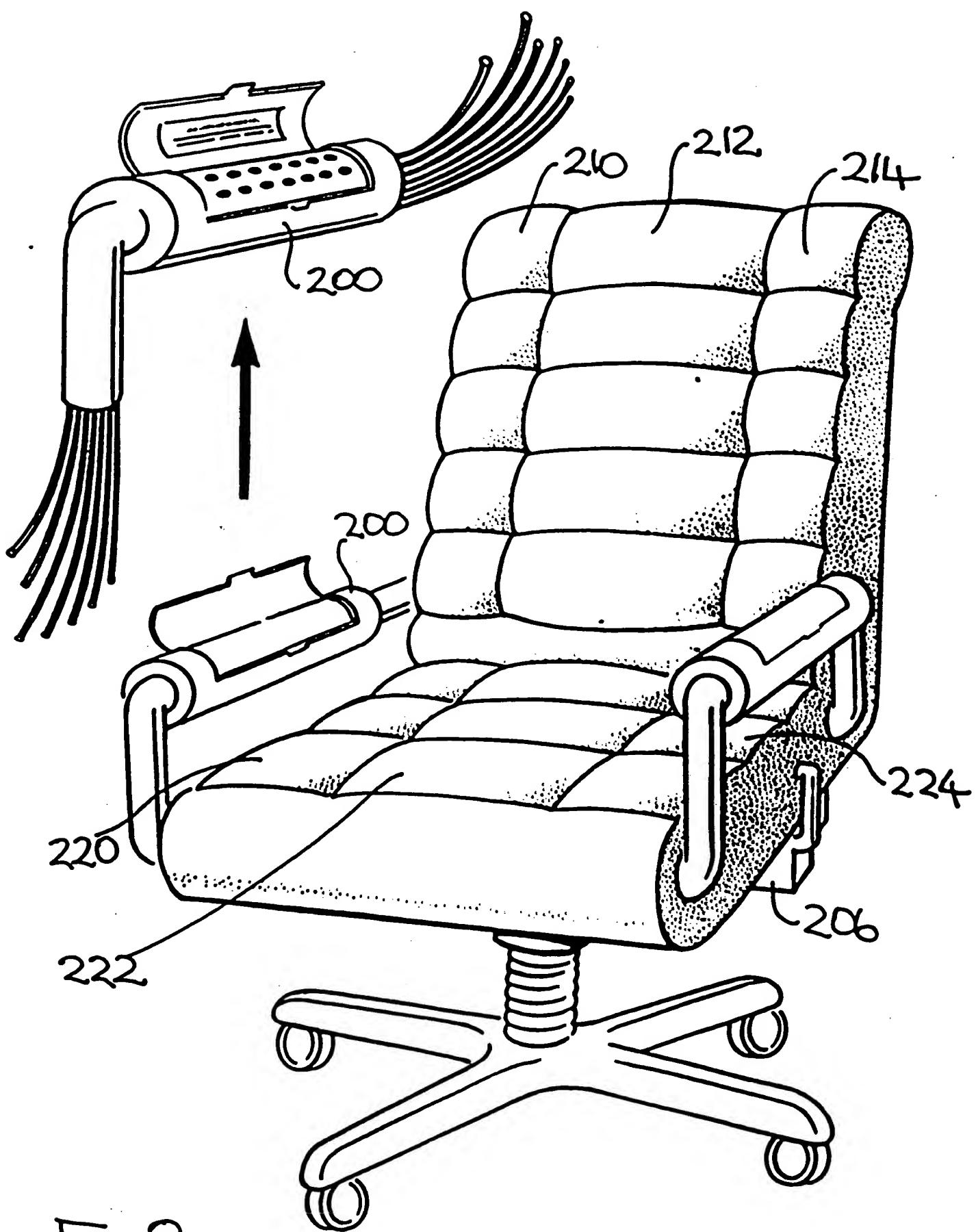


Fig. 8

Fig. 9(a)

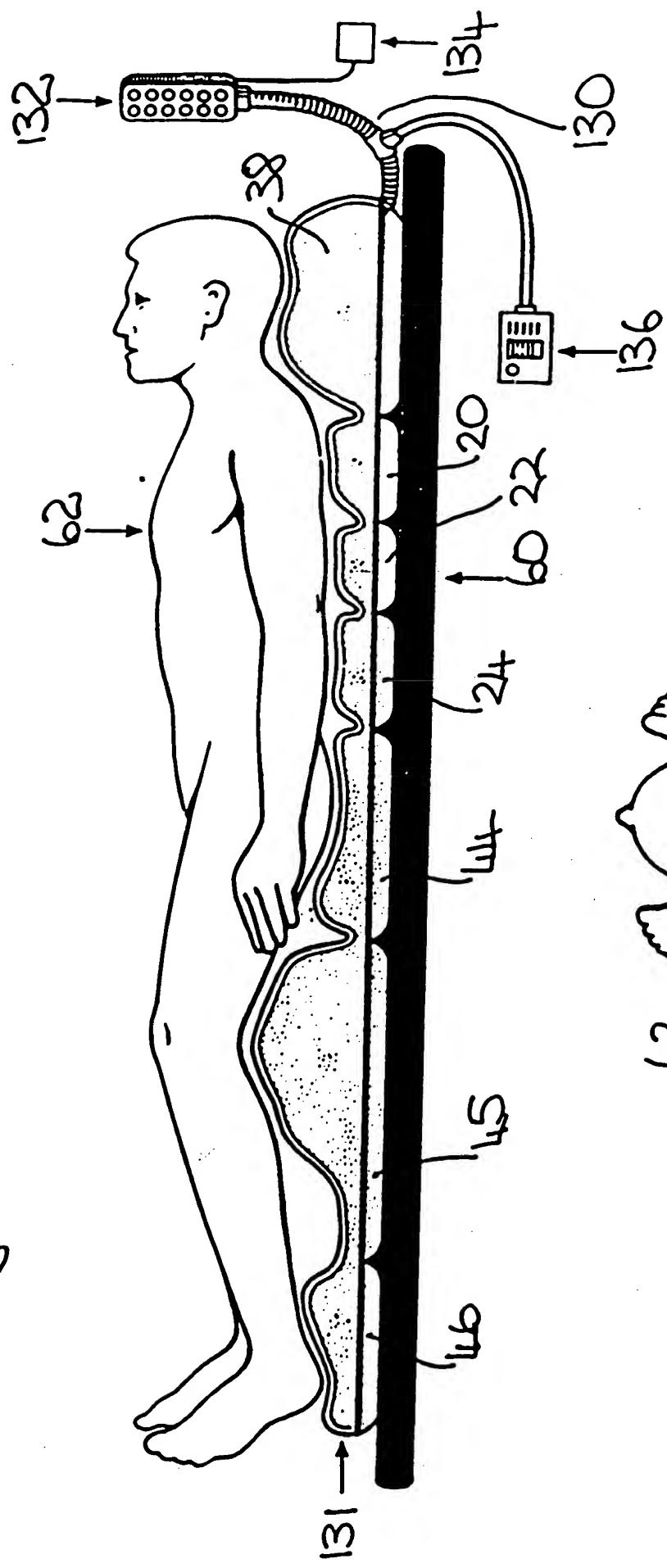
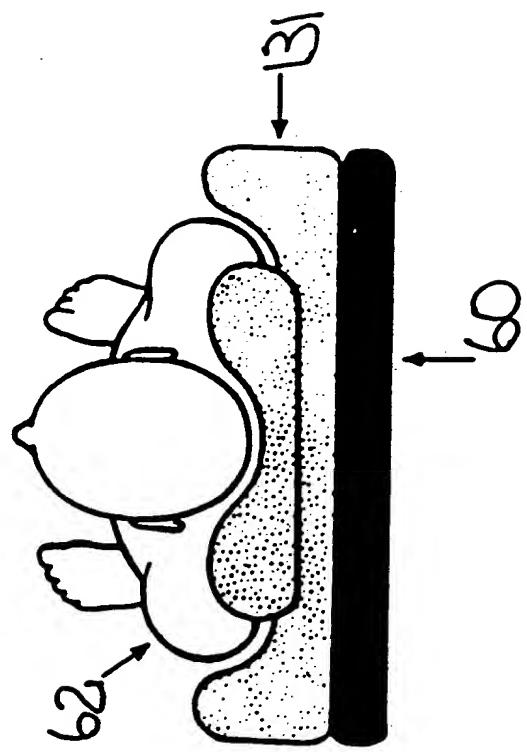


Fig. 9(b)



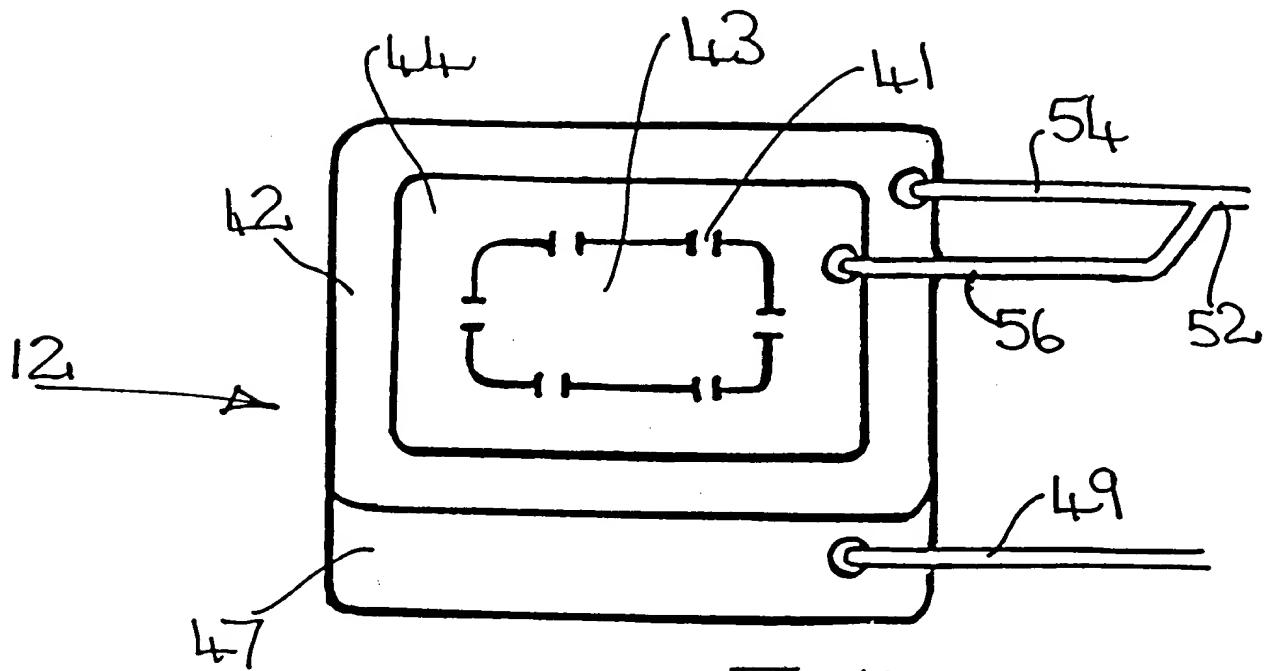


Fig. 11

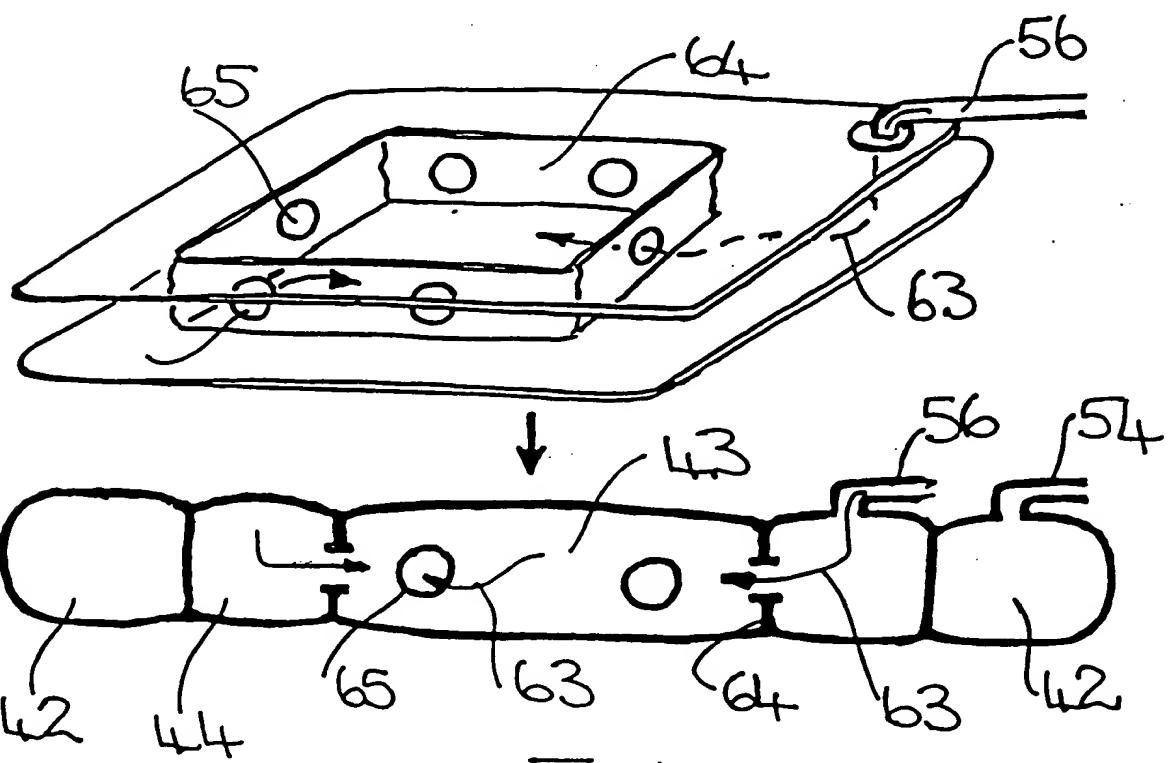


Fig. 10